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Reprinted from Transactions of the Thirtieth North American Wildlife and Natural Resources Conference, March 8, 9 and 10, 1965, Published by the Wildlife Management Institute, Wire Building, Washington 5, D. C.

DIFFERENTIAL VULNERABILITY OF MALE AND FEMALE CANVASBACKS TO HUNTING

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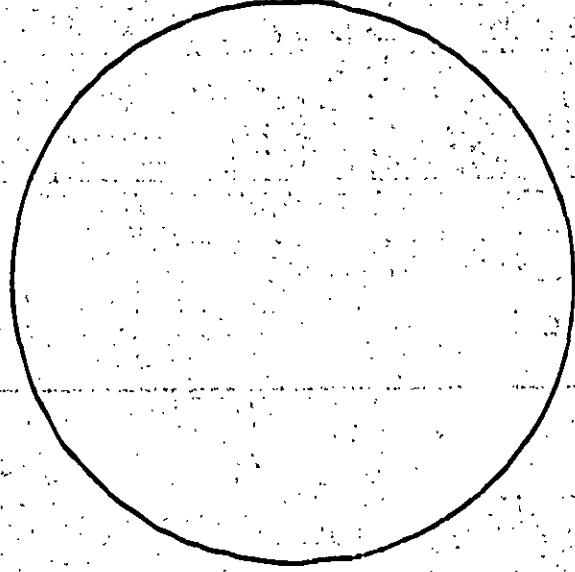
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Considerable effort has been devoted to the study of waterfowl in hunter's bags and to the analysis of banding returns to determine the effects of hunting on the sex and age structure of waterfowl populations; however, except for discussions of crippling losses, the behavior of living ducks in the actual hunting situations has received comparative little attention. Hochbaum (1944) found more females than males in the canvasbacks shot by hunters in Manitoba and suggested that hunting may be a factor in the disproportionate sex ratio of canvasbacks. Smith (1946) found more juvenile than adult canvasbacks in hunter's bags, but indicated that "no flight or decoying differences were noted in the age classes." In a study of mallards responding to decoys Anderson (1947) found that juvenile females received more shooting pressure than males. Tendencies for higher mortality rates in female than in male canvasbacks have been reported from banding data by Geis (1959) and DeGraff *et al.* (1961). Bellrose *et al.* (1961) summarized banding and hunter bag statistics of many species of North American ducks including canvasbacks and concluded "the effect of hunting on the sex ratios of the entire North American duck population is probably insignificant." Thus, there seems to be little agreement in the literature concerning the effects of hunting on the composition of waterfowl populations.

This report describes an attempt to record and analyze the behavior and subsequent mortality patterns of canvasback ducks as they responded to decoys and flew across shooting passes in southern Manitoba in 1960. The study is part of a larger investigation of population dynamics in canvasback ducks which was conducted from 1958 to 1962, (Olson 1964).

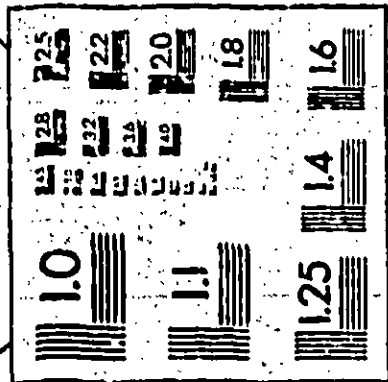
Preliminary observations of migrating canvasbacks and inspection of hunter's bags in the autumn of 1958 and 1959 indicated that adult male canvasbacks did not appear in hunter's bags in the same proportion as they existed in the wild populations. In aerial and ground surveys of canvasback populations at Oak Lake and the Delta Marshes, Manitoba, 25-30 percent of the canvasbacks were adult males. In contrast, only 5-15 percent of the canvasbacks in hunter's bags were adult males. Narratives of hunters and guides suggested that there were behavioral differences between canvasbacks,

IMAGE EVALUATION TEST TARGET (MT-2)



SERIF (BASKERVILLE) SIZE SANS SERIF (MICROFONT)

Point
Oz7h9 B5cIP W08nk 8t1zx l4C9E83 B18AJ Z7QVI OKJDO
C6Jlm Zm79x 3s13l lskry l26FRKM EB7AU FUDWMBOONF
KP7ye Rhodl Unknkl Beald 10 VILNU MZHSF XM880 HMEKH
8 XH880 HMEKH XYAHQ SIDDS
6 12568 USM7P PH5B OIKOC
4 12568 USM7P PH5B OIKOC



POINT SIZE
4 6 8 10 12 14
FUTURA
NEWS GOTHIC
K2b8t Okjdg
14 4ef8k Gmn0c
12 Zlo6x Ge92
7n34a 6Y3sl
Y0r8j A7o7q
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10 9ss9d Ll1cdg
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because most hunters claimed a preference for shooting the larger, bright-colored males. It was also observed that guides used predominantly female colored decoys in the marshes which are frequented by adult females and juveniles, but they used predominantly male colored decoys on the larger lakes frequented by adult males. These clues and others led to the intensive study of canvasbacks in hunting situations as described below.

POPULATION SURVEYS

Canvasback populations on the study areas at Oak Lake, Dauphin Lake, and the Delta Marshes in southern Manitoba were periodically censused from an airplane and on the ground to determine the chronology of fall migration and the proportion of adult males present on the study areas. During September and October the juvenile canvasbacks of both sexes resemble the adult females in general plumage color. The adult males, however, are distinctly brighter and can be readily identified as they fly across passes, or respond to decoys, or when counted from an airplane during surveys. Thus, two major categories: "white"—adult males and "brown"—adult females and juveniles were used in this study. Whenever possible the sex and age composition of the "brown" canvasbacks was more accurately ascertained by detailed examination with field glasses or by selective shooting.

DECOY EXPERIMENTS

The objectives of the decoy studies were: (1) to determine if the sex and age classes of canvasbacks responded to decoys differently; (2) to determine if canvasbacks exhibited a preference for decoys painted as female or male canvasbacks; and (3) to determine if canvasbacks responded differently to varying numbers of decoys. For most experiments 50 decoys, 25 painted as males and 25 painted as females, were used. Usually the decoys were placed in two groups with 25 males in one and 25 females in the other group approximately 50 yards away with the observer between the groups or on the side, Figure 1. Occasionally 25 decoys either all male, all female, or mixed were set out. The decoys were evenly spaced and placed in approximately circular patches so that the arrangement could be duplicated in successive trials.

A total of 1,761 canvasbacks in 669 flocks were observed and recorded responding to the decoys which were set out 27 times between August 24 and October 31, 1960. For purposes of recording and tabulation one canvasback responding to decoys alone was considered a "flock" as was any group of two or more canvasbacks, and each flock was recorded on a separate card, Figure 2. Every canvasback



which responded to the decoys was recorded as: landing (in or near decoys); low; medium; or wide. The low, medium, and wide are subjective ratings in terms of shotgun range. In general, low corresponds to 40 yards or less, medium 40-60 yards, and wide beyond 60 yards. For most of the observations a written description of the flight into and/or around the decoys was also recorded, see 'comments' in Figure 2.

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Figure 2. Punch card form used for recording responses of canvasbacks to decoys

The adult female and juvenile canvasbacks were markedly more vulnerable to hunting over the decoys than were the adult males. In 858 observations of females and juveniles responding to decoys, 597 or 70 percent either landed in or flew low over the decoys, Table 1. In a comparable 881 observations of adult male canvasbacks, only 360 or 41 percent landed in or flew low over the decoys. Thirty-two percent of the adult females and juveniles actually landed in or near the decoys as compared to 19 percent of the adult males. In the "brown" birds which were accurately identified as to sex 29 of 46 females landed in the decoys. The written descriptions of the flights into the decoys revealed that adult males tended to circle outside the decoys without landing while the females and juveniles frequently flew directly in and landed in the decoys.

TABLE 1. COMPARATIVE RESPONSES OF 1,741 CANVASBACKS TO DECOYS
MANITOBA, AUGUST 21 TO OCTOBER 30, 1960

Date	Adult Males					Adult Females and Juveniles				
	landing	low	med.	wide	total	landing	low	med.	wide	total
8/21-9/29	64 33%	29 22%	13 10%	19 15%	125	121 11%	131 13%	15 5%	31 11%	302
9/30-10/31	101 13%	163 22%	134 21%	341 44%	739	132 27%	191 31%	82 15%	131 24%	536
Total	165 19%	191 22%	171 19%	560 40%	881	253 32%	322 38%	97 11%	161 19%	838

The patterns of vulnerability changed somewhat as the fall migration progressed. In September, when the canvasback population was mostly females and juveniles, all of the canvasbacks including adult males responded to the decoys more directly by landing or crossing lower. In October, when the canvasback population was mostly adult males and the canvasbacks were distributed in larger flocks, the canvasbacks responded to the decoys more warily. However, throughout the entire fall migration the responses of females and juveniles showed they were more vulnerable to shooting over decoys than were the adult males.

Rather different responses of canvasbacks to 25 and 50 decoys were obtained, especially in the later half of the fall migration when canvasbacks responded to 50 decoys more readily than to 25 decoys. In trials conducted between September 30 and October 31 at Dauphin Lake 16 percent of 376 adult males and 44 percent of 220 adult females and juveniles either landed or flew low over 25 decoys. In comparison 56 percent of 238 adult males and 86 percent of 175 adult females and juveniles landed or flew low over 50 decoys. In Septem-

ber, during the earlier part of the migration, there was considerably less difference in the responses of canvasbacks to 50 and 25 decoys.

As judged by differences in behavior, the canvasbacks also exhibited some preference for decoys of their own color (sex). In the adult male responses only 8 percent of 258 birds either landed or flew low over 25 female decoys, but 33 percent of 117 birds landed in or flew low over 25 male decoys. The differences in response of birds in the adult female and juvenile category was reversed: 28 percent of 135 canvasbacks landed or were low over 25 female decoys, but 52 percent of 85 canvasbacks landed or were low in the 25 male decoys. Part of this reversal seems attributable to juvenile males which are categorized with the adult and juvenile females. Of 30 juvenile males which were accurately identified, 22 exhibited preferences for male decoys. The differences in response to decoys painted as males or females was most pronounced in October when most of the canvasbacks were males. Thus, it can be said that male canvasbacks show a clear preference for male decoys, but adult and juvenile females are not as selective.

BEHAVIOR OVER A SHOOTING PASS

Observations of canvasbacks flying across a typical pass at Oak Lake, Manitoba were made on 5 mornings and 7 evenings during September and October. The number of canvasbacks in each flock, color (white or brown), time, direction, and height in terms of shotgun range (low, medium and high) were recorded. Miscellaneous observations such as turning or circling over the pass, tendency for males to lead flocks and weather conditions were also noted.

The adult females and juveniles were more vulnerable to shooting over the Oak Lake pass than were the adult males. The females and juveniles tended to cross lower than did the adult males, Table 2. They also tended to turn or circle over the pass and often they crossed the pass diagonally, thus allowing greater opportunity for shooting. Adult males, on the other hand, usually circled over the water well away from land, then crossed the pass directly and quickly. In addition, the females and juveniles appeared over the passes proportionately more than the adult males. Of the 2,218 canvasbacks observed 1,812 were females or juveniles and only 406 or 14 percent were adult males, Table 2. In comparison the population of canvasbacks at Oak Lake contained between 25 and 61 percent adult males (Table 3).

Adult male canvasbacks tended to lead the flocks in which they were flying. Of 62 flocks examined 39 (63 percent) were led by drakes but only 35 percent of the birds in the flocks were males.

TABLE 2. COMPARATIVE BEHAVIOR OF CANVASBACKS OVER A SHOOTING PASS
OAK LAKE, MANITOBA--1940

	Adult Males				Adult Females and Juveniles			
	low	med.	high	total	low	med.	high	total
9/11-9/13	28 18%	37 23%	93 59%	158 100%	556 13%	367 28%	383 29%	1306 100%
10/2-10/4	27 11%	108 41%	111 43%	246 100%	91 18%	265 41%	208 31%	564 100%
Total	55 11%	145 30%	204 61%	404 100%	647 30%	632 32%	591 30%	1870 100%

This "leading" may be a factor in male mortality since hunters often try for the lead duck in a flock.

Canvasback flocks crossing the pass during the first one-half hour after dawn and the last 30 minutes before dusk flew lower than flocks crossing in the brighter portions of the day, and the canvasback flocks also tended to cross the pass lower on cloudy than clear days.

FLOCK SIZE IN RELATION TO VULNERABILITY

The distribution of canvasbacks according to the size of flocks observed in the decoy trials and pass observations has been plotted in Figure 3. It is apparent from Figure 3 that female and juvenile canvasbacks have a greater tendency to occur in small flocks than do the adult males. There were more than twice as many single adult female or juvenile canvasbacks as there were single adult males and the proportion is almost two to one for flocks of two and three. Hochbaum (1944) also noted on the Delta Marsh that "most strays, singles, twos and threes are females."

TABLE 3. PROPORTION OF ADULT MALES TO ADULT FEMALE AND JUVENILE CANVASBACKS IN: POPULATIONS, RESPONSE TO DECOYS, AND PASS OBSERVATIONS

Date	Location	Population*	Decoys	Pass
8/21-9/6/40	Delta Marsh	31:40 (251)	64:10 (127)	
9/10-9/23/40	Delta Marsh	34:52 (633)	27:73 (103)	
9/11-9/19/40	Oak Lake	23:75 (3,338)	11:86 (180)	11:59 (1,169)
9/27-2/30/40	Dauphin Lake	81:16 (3,673)	87:13 (113)	
10/2-10/8/40	Oak Lake	61:39 (2,997)	10:51 (209)	33:67 (270)
10/26-10/31/40	Dauphin Lake	81:19 (7,800)	61:39 (299)	

* Ratios obtained by aerial surveys and checked by ground observations.

The probability of mortality (upper axis in Figure 3) was obtained by assuming that the average hunter kills or mortally wounds one canvasback for every two shooting opportunities. A single canvasback or a flock of canvasbacks responding to decoys or crossing a shooting pass can be considered a shooting opportunity. Thus, one can examine the number of canvasbacks in the various flock sizes in relation to estimated mortality. From Figure 3 it can be seen that individual ducks in the smaller flocks have greater probabilities of mortality than those in larger flocks; therefore, on the basis of distribution in these flock sizes, the female and juvenile canvasbacks appear to be much more vulnerable to hunting than do adult males.

The behavior of canvasbacks in small flocks also indicates that they are more vulnerable than canvasbacks in larger flocks. Single canvasbacks and doubles, whether adult males or females and juveniles, had a greater tendency to cross the pass low and to fly over the decoys low or land in the decoys than did the canvasbacks in flocks of three or more. However, it should be noted that, even in flocks of three or more, the adult females and juveniles are more vulnerable

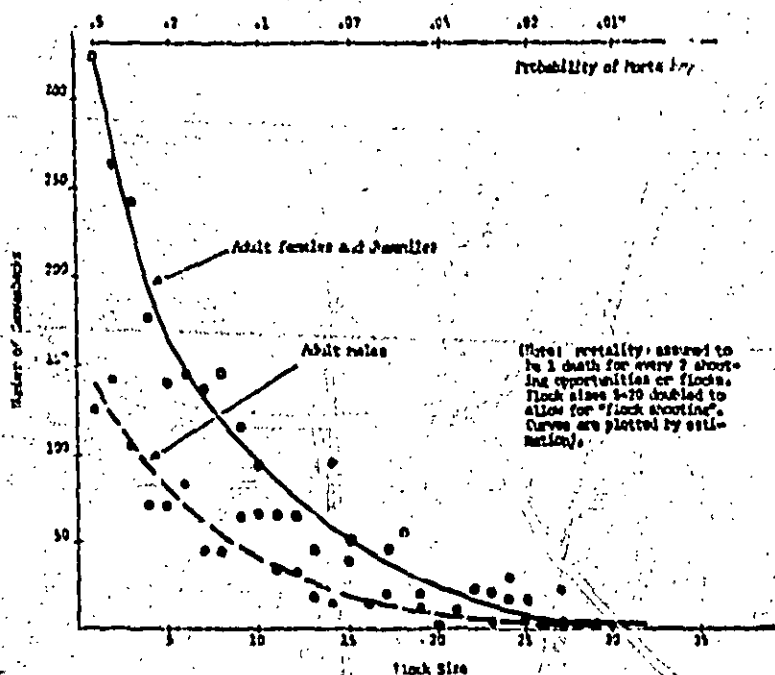


Figure 3. Number of canvasbacks by flock size and estimated mortality

than adult males, and, therefore, their greater vulnerability is not due entirely to small flock sizes or to the behavior of canvasbacks in these small flocks.

The average flock size of canvasbacks responding to decoys was 2.5, while flocks crossing the pass averaged 5.7 birds. Much of this difference is caused by major flights or movements of canvasbacks, such as morning and evening feeding flights, which frequently cross the passes. Decoys, on the other hand, tend to draw only a few responses from these large movements.

DIFFERENCES IN ACTIVITY IN MALE AND FEMALE CANVASBACKS

The data in Table 3 indicates that proportionately more adult females and juveniles flew across the pass or responded to decoys than were present in the canvasback populations on the study areas. These differences were found in all the census periods except for the earliest observations on the Delta Marsh. This seems to indicate that adult females and/or juvenile canvasbacks are more active or tend to fly more than adult males. Observations during censuses at Oak Lake in 1959 and 1960 tend to support this explanation. The flocks of canvasbacks flying over large rafts of canvasbacks on the water frequently contained greater proportions of brown birds (females and juveniles) than were present in the flocks on the water, and when I alerted flocks of canvasbacks by my presence, the females and juveniles were usually flying before the adult males.

To further check for differences in activity, a study was made on a flock of captive adult canvasbacks at the Delta Waterfowl Research Station. Repeated observations, both indoors in winter and outdoors in summer, and by two independent observers resulted in the conclusion that females were more active than males. Of course, a tendency for greater activity of captive female canvasbacks can in no way be equated to a greater disposition to fly across shooting passes or into decoys, but it does suggest that females, especially adult females, are more active than adult males.

EFFECT OF FEMALE VULNERABILITY ON SEX RATIOS

The data presented here indicate that canvasback females and juveniles are decidedly more vulnerable to hunting over decoys and on passes than are adult males. The contribution in smaller flock sizes and tendency of females to be more active than males are also mortality factors which bear heavily on females. Although there is need for additional investigations of this kind, these facts suggest that the differences in vulnerability to hunting may be the cause of an imbalanced sex ratio in canvasback ducks.

Since canvasback females appear to be more vulnerable to hunting than are adult males, they should be killed earlier in the season and at a younger age than the adult males. McIlhenny (1940) found this to be true for lesser scaups, ring-necked ducks, and pintails whose males did in fact outlive the females. Geis (1949) demonstrated slightly higher mortality rates for females than for males in some populations of canvasback ducks but not in others. In a study of canvasbacks banded in New York State the females exhibited higher mortality rates than the males, DeGraff *et al.* (1961). Bellrose *et al.* (1961) examined the year of banding returns from canvasbacks banded by Ducks Unlimited between 1939 and 1950 on the Prairie Provinces of Canada and tabulated a slight, but non-significant tendency for proportionately fewer males in hunter's bags. In general the differences in the mortality rates of male and female canvasbacks as reported from these banding data appear not large enough to produce the observed spring sex ratios of approximately two males per female in the known life span of canvasback ducks.

In view of the greater vulnerability of female canvasbacks to hunting one may well ask why the mortality rates are as closely balanced as reported? Apparently, the adult females are killed in excess of adult males until the canvasback population contains approximately twice as many males as females and then the males become more vulnerable due to their relative abundance and are killed in excess of females. The estimated balance point of 65 percent males is suggested by the spring sex ratios which for many years have been approximately two males per female, (Hochbaum 1944, and Olson, 1964).

The following data support the suggestion that there is a point where the numerical abundance of male canvasbacks balances against female vulnerability. Bellrose *et al.* (1961) listed proportions of male canvasbacks in the kill from: Manitoba, 41 percent; North Dakota, 56 percent; and Illinois, 65 percent. Geis (1959) reported for certain populations of canvasbacks a similar tendency for females to die before males in the hunting season. Of course, these differences in the composition of the kill could also be obtained if hunting seasons in the various states matched the differential migration of the sexes. On wintering areas there is a tendency for females to be killed in excess of males except where populations contain more than 65 percent males:

	Population	Kill
New York	77% ♂♂	73% ♂♂
Maryland	63% ♂♂	59% ♂♂
Louisiana	66% ♂♂	51% ♂♂
North Carolina	53% ♂♂	42% ♂♂

Although these data are from a wide variety of sources (Longwell and Stotts [1958, DeGraff et. al. [1961], Criteher [1949] and personal communications) and include data from different years and some small samples, they do suggest that the kill of male and female canvasbacks follows predictable patterns and that the sex ratio in hunter's bags is equal or contains more males than females only after the population contains somewhat more than 60 percent males.

MANAGEMENT IMPLICATIONS

If, as this study indicates, the disproportionate sex ratio in canvasbacks is produced by the gun, corrective measures may be within the realm of management possibilities. Many canvasback hunters now selectively shoot drakes and it seems that more could be encouraged to do so. However, simply encouraging hunters to kill drakes will have no beneficial effect on canvasback populations or productivity unless some means are found to protect females from indiscriminate shooting. If the females are not adequately protected, encouraging hunters to shoot males will simply make more females vulnerable by removing the males which act as a buffer. Similarly, special regulations for protection of females in the northern parts of the flyways, such as Hochbaum (1948) has advocated for Manitoba, will have no real effect unless females are protected along the entire flyway. On the other hand, hunters in wintering areas are in a particularly favorable position to practice selective shooting and thereby increase the proportion of females going back to the breeding areas each spring.

The results obtained in the decoy trials and pass observations provide some possibilities for manipulating the kill of canvasbacks by sexes. Pass shooting seems to be particularly hard on female canvasbacks, and therefore, regulations might be proposed to discourage pass shooting and encourage the use of decoys. Pass shooting is best in the periods of poor light such as dawn, dusk, and cloudy days, and under these conditions there is less chance for selection of males. The use of decoys offers the further advantage of smaller flock sizes and greater possibility for visually selecting male canvasbacks. The indications that male canvasbacks will respond better to all male decoys and to larger numbers of decoys may eventually provide a means of selectively decoying males. For instance, one easily enforced regulation would be the requirement for using all male canvasback decoys. Laws such as Manitoba has had which restrict hunters to 25 decoys or the current bag limits in the United States tend to promote the shooting of females since hunters are discouraged from setting up large spreads of decoys, which are more attractive to males.

In any scheme for managing the canvasback kill by sexes the overall greater vulnerability of the female stands out as the most important single factor and indicates that recognition of male and female canvasbacks and abstinence from shooting females may well be required from hunters. At Delta, Manitoba most canvasbacks in hunter's bags occurred as one or two juveniles or adult females in a mixture of several species shot by hunters using mallard or mixed decoys or shooting over passes. In other words, the average shooter who attempts to kill whatever comes into the decoys or across the passes far outnumbers the devoted canvasback hunter who might select males. However, due to the relatively great difference in color of plumage, requiring the recognition of canvasbacks by sex seems at least as reasonable as distinguishing between certain species of ducks such as ring-necked ducks, scaup, and redheads which has already been asked of hunters. In addition, the abstinence from shooting female canvasbacks, or any other nondescript colored duck for that matter, may actually lead to desirable increases in the quality of the sport.

ADDITIONAL RESEARCH NEEDS

The results from these studies are limited in many ways, and a great deal of research will be required to determine the vulnerability patterns of canvasbacks in other areas. My communications with hunters on the Chesapeake Bay and at the Bear River Marshes in Utah indicate that females are more vulnerable than males in both areas, but that this pattern can vary markedly with changes in weather and season. In addition to studies in different areas and at various times during the season, there is need to evaluate the effects of weather, canvasback behavior in actual shooting situations, and a greater variety of hunting methods and decoy combinations. If the studies are carried out after November 1, the juvenile males and females will have attained distinct plumages and the problems in identification of sexes will be greatly simplified. Because of restricted seasons and limitations in manpower most of the observations reported in this paper are without actual shooting. Canvasback behavior may be conspicuously different when they are being shot at, and the kill composition during the study periods would provide valuable comparisons with canvasback behavior patterns. It should be mentioned that shooters cannot be fully aware of differences in behavior. This was apparent in the comments of hunters, when during the course of this study, they laid down their guns and watched.

There is reason to believe that different vulnerability patterns may exist between the sexes in many species of ducks. Recently, Harmon (1962) reported a sex ratio of 4.36 males per female in large rafts

of lesser scaup off the Louisiana coast. During the same winter Louisiana hunters bagged one male scaup for each female in a sample of 111 birds checked (pers. comm. Morton Smith). The tendency of males to (1) occur in large flocks, (2) migrate later in the fall, and (3) use large bodies of water, have been noted in many species of ducks. These are all factors which are associated with reduced availability to hunters and probably with differential patterns of vulnerability between the sexes. The differences in patterns of vulnerability between the sexes within a species and between species may also produce significant bias in banding returns. Although there is still a great need for evaluating the effects of natural or non-hunting mortality on sex ratios of ducks, it seems that the sex ratios of the various species of ducks may one day be regarded as an expression of the comparative vulnerability of males and females to hunting.

The indications of basic differences in the amount of activity between male and female canvasbacks are of considerable theoretical importance. These differences may have been the original cause of imbalance between the sexes when canvasbacks were first hunted. This thought leads to the further consideration that much of the population dynamics of present day canvasbacks may be the result of hunting. One-half of the male canvasbacks do not accompany females to breeding areas and have no apparent function in reproduction. They raft up in large flocks in May and June and spend the summer on feeding and molting habitats completely away from breeding females. If these males are truly gun-produced surpluses, then there is need to carefully inspect the structure of canvasback populations as balanced systems which were generated by hunting in the past and which are maintained by differences in male and female vulnerability to hunting. This suggestion applies to other species of waterfowl as well.

SUMMARY

In September and October, 1960, 3,979 canvasbacks were observed and recorded as they responded to decoys and flew across shooting passes at Oak Lake, Dauphin Lake, and the Delta Marshes in southern Manitoba. Aerial and ground surveys, timed to match these periods of decoy and pass observations provided information on the migration, sex and age composition, and size of the canvasback populations.

The observations of canvasbacks responding to decoys indicate that the adult females and juveniles are markedly more vulnerable to hunting over decoys than are the adult male canvasbacks. Females and juveniles tend to respond to decoys by flying right in and landing or crossing low over the decoys, but the adult males tend

to circle at greater distances, and land in the decoys less often than females and/or juveniles.

Female and juvenile canvasbacks are also more vulnerable to shooting over passes than are adult males. They cross the passes lower and tend to circle over the passes more than the adult males. When adult males flew across the passes they tended to fly higher, to lead the flocks, and to cross without turning. Canvasback flocks flew across the shooting passes lower at dawn and dusk and on cloudy days.

There is a strong tendency for female and juvenile canvasbacks to occur in smaller flocks than adult males, and the birds in these smaller flocks are much more prone to shooting mortality. The canvasbacks which responded to decoys occurred in smaller flocks than those that crossed the passes.

Adult female canvasbacks appear to be more active than adult male canvasbacks. Juveniles also tend to be more active than adult males. This tendency to be more active is a factor in mortality since in hunting situations it brings the female and juvenile canvasbacks into contact with hunters more often.

There are differences in the migration of adult male canvasbacks as compared to females and juveniles, and there are corresponding differences in the patterns of vulnerability. In September the migrating canvasbacks in southern Manitoba are primarily females and juveniles, but all categories—adult males, adult females, and juveniles are more vulnerable to decoy and pass shooting than in October when the population is primarily adult males. However, in both September and October the adult females and juveniles are more vulnerable than the adult males.

Some differences in response were obtained by altering the number and color (sex) of the canvasback decoys. Canvasbacks landed in or were low over 50 decoys more than 25 decoys, and the greatest degree of change occurred in the response of adult males. Canvasbacks tended to prefer decoys of their own sex, and the males especially, landed in or flew low over male decoys more often than female decoys.

The disproportionate sex ratio of canvasbacks appears to be largely the result of differential vulnerability of the sexes to hunting. It appears that females are killed in excess of males until the population contains 60-65 per cent males and then the males are killed in greater numbers, thus the female vulnerability is balanced by the numerical abundance of males.

Selective shooting of male canvasbacks is possible. Some hunters practice selective shooting now, and in addition, male canvasbacks

will respond more readily to large numbers of white (male) decoys. However, an increased harvest of canvasback males will only result in decreased canvasback populations unless females are protected from indiscriminate shooting.

Additional investigations of the behavior of canvasbacks and other species of waterfowl in hunting situations are needed. These studies should cover many migration areas and wintering habitats, and include surveys of population size, sex ratios, and the composition of hunter's bags.

ACKNOWLEDGMENTS

This study is part of a larger investigation which was sponsored by the University of Minnesota and the Delta Waterfowl Research Station. William H. Marshall, H. Albert Hochbaum and Angus Gavin served as advisors, and the Ingersol Foundation and the North American Wildlife Foundation provided financial support. A great many individuals have contributed time and interest to this study. Some known by name include: Herman Battersby, Norton Cross, Robert Gaylord, Sr., David Hatch, Robert Jacobs, Fred Maytag, Sam Mulder, Orrin Rongsted, Morton Smith, Roy Walsh, and Peter Ward, but there are many more including sportsmen who have contributed duck wings or other information. I owe a large debt of gratitude to all.

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DISCUSSION

Mr. LEE SMITH (Detroit): I would just like to ask whether there is a disproportionate in sex ratio—in fact, whether this is true of all other species as it is of the canvasbacks.

Mr. OLSON: In general, diving ducks have more disproportionate sex ratios than dabblers. Observations in Louisiana suggest a vulnerability pattern in lesser scaup similar to that in canvasbacks. I also think it was Harmon who, about two years ago, reported there were 4.38 males per female in offshore rafts, but in the same year, for birds examined in the hunting season, the kill was approximately one male per female. Therefore, I suspect that this same phenomenon applies to dabbling ducks, because their sex ratios are not as severely deranged.

Vice CHAIRMAN SCHMIDT: Are there further questions?

Mr. AL GIBB: I would like to clarify one point that you made and this relates to the matter of whether the adult females had the same annual rate of mortality as the adult males. It seems rather clear that in the adult populations there was some distortion. It also seems clear that in most species the sex composition of each year's recruitment has an even sex ratio. When these two conditions are present, there, of necessity, must be a higher rate of mortality for females. I have been given the impression, from what you said that you did not feel this was the case in this species and I don't see how it can help but be otherwise.

Mr. OLSON: No, I believe that there is a higher rate of mortality in the females, but I was impressed that the difference in the mortality rates between males and females was not larger in view of the great differences in vulnerability. I suspect this is due to the buffering effect of the extra males.

Mr. GIBB: There is one other angle here that I would like to elaborate on and that is that your data shows a rather marked change in ratio of males to females between the two specific time periods that you showed in one of your tables. It seems to me that a component of differential vulnerability is changes in availability of birds of particular age and sex in various places.

Now, what are your interpretations of this phenomenon as you saw it in your data? It would appear that either the females left your study areas as the season progressed or the males arrived.

Mr. OLSON: A differential migration does take place—females and juveniles first and then males later. Of course there are some other factors we should consider here: Because of their tendency to be distributed in small flocks and the use of very small habitats and closeness to the shoreline areas, females and juveniles tend to show up in the miscellaneous type killing that take place in many small marshes and lakes down the flyway. On the other hand, the males have a very definite preference for large bodies of water and, in general, when we go to look for canvasback population and hunting, these are the areas that we survey.